

# **HABITAT-BASED INVENTORY OF AMPHIBIANS AND REPTILES OF JAMESTOWN ISLAND AND VICINITY COLONIAL NATIONAL HISTORICAL PARK**

Joseph C. Mitchell

Department of Biology  
University of Richmond  
Richmond, VA 23173

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P.O. Box 210  
Yorktown, Virginia 23690



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## Executive Summary

Plans for the Jamestown Island 400 project include alteration of some natural habitat on the island and adjacent mainland. These alterations, such as construction of additional parking lots, boat docks, and trails will negatively impact native species of flora and fauna, especially amphibians and reptiles. The objectives of this study include: (1) obtain a full list of the species of amphibians and reptiles that occur in this area, including any recognized rare and listed species, (2) associate each species with recognized habitat types, (3) provide quantitative estimates of relative abundance of selected species when standardized protocols are used, and (4) provide management recommendations for these two groups of vertebrates.

A variety of field techniques were used in this study: haphazard visual encounter surveys, frog call surveys at night, dipnets, minnow traps, turtle traps, road driving at night. The haphazard technique produced the most encounters and information. Eleven species of frogs, 7 species of salamanders, 7 species of turtles, 3 species of lizards, and 8 species of snakes were encountered in the study area during this study at 155 separate study sites. A total of 801 individual amphibians and reptiles were captured during the course of this study: 482 amphibians (295 frogs, 187 salamanders) and 319 reptiles (191 turtles, 82 lizards, 46 snakes). No federal or state endangered or threatened species of amphibian and reptile was encountered during this survey.

The planned Alternative that will have the least impact on amphibians and reptiles is Alternative D. Construction of parking areas and additional roadways on Neck-of-Land and on Jamestown Island will negatively impact important populations of amphibians and reptiles no matter which Alternative with planned construction is selected.

Construction of boat docks will result in loss of habitat for amphibians and reptiles and increased boat traffic on the area's waterways. Boat propeller strikes cause mortality of Red-Bellied Cooters in Powhatan Creek and possibly Diamond-backed Terrapins, a species in decline. Increased traffic because of the new boat docks will only exacerbate a current management problem.

The effects of the proposed trails in the various Alternatives for the Jamestown Island 400 project on amphibians and reptiles are varied. They range from little impact for trails along existing roads in the existing public areas to considerable impact in areas currently lacking trails in the Neck-of-Land area. Any change to the hardwood forest in the Neck-of-Land area will have consequences to the long-lived, sentinel Box Turtle population.

Removal of downed woody debris from areas along the inner and outer loop roads on Jamestown Island would result in reduced populations of several species of reptiles. Such a practice may be in conflict with the National Park Service mandate of maintaining viable populations of all vertebrates.

The variety of habitat types on Jamestown and vicinity should be viewed as a habitat matrix at the landscape level rather than as separate habitat types. Long-term management of habitats in Colonial National Historical Park would be well served if management issues and potential construction impacts were viewed from this perspective.

Several habitats and sites on Jamestown Island and on the mainland should be evaluated further for wildlife (all species of vertebrates and invertebrates). Examples are the ephemeral wetland south of the Glass House, the freshwater marshes in the forests to the east of the visitor area on the island, and the hardwood stand near the gate to the loop roads. These habitats support species that occur in few places in this area.



The Eastern Box Turtle populations on the island and in the Neck-of-Land area should be studied from a population and disease perspective. This species is rightly viewed as a sentinel species that can reveal much about the quality of the local environments and habitats. This species would be the most dramatically affected by construction of parking lots and trails in the Neck-of-Land area during the Jamestown Island 400 project.

The natural history of Jamestown Island and vicinity was a very important backdrop to the cultural history that occurred here. Historians and interpretive staff should not ignore the flora and fauna. It would be most beneficial to visitors to gain an appreciation of the natural history of the island and how it influenced the cultural history.

## **Introduction**

When Captain John Smith and his fellow travelers landed on Jamestown Island in 1607, they encountered a diversity of amphibians and reptiles that were as new to them as the native inhabitants. They were undoubtedly afraid of the snakes of the area, ate turtle meat, and heard frogs calling from the wetlands. Indeed, Captain Smith mentioned several reptiles in his published works, including green snakes and rattlesnake rattles (Smith, 1612 [1986]). Few people appreciate just how much the natural history of a new area influences newcomers. The animals and plants were all foreign to the Europeans, and they had to learn what was useful and what to stay away from by their interactions with the Native Americans. Thus, understanding the natural history of a historical area is as important as understanding the cultural events that took place at that time in history (Mitchell, 1994). Such an endeavor provides insights into the context within which the cultural events and human actions took place.

Modern use of Jamestown Island and adjacent National Park Service mainland centers around historic recreation and interpretation. The Jamestown Island 400 project has generated plans to accommodate many more people and vehicles than usually visit this park in most years. These plans include alteration of some natural habitat on the island and mainland. These alterations, such as construction of additional parking lots, interpretation buildings, and trails may negatively impact native species of flora and fauna. The possible presence of rare species, as well as the National Park Service's plans to conduct full species' inventories, generated the need to conduct a survey of the amphibians and reptiles of the area, as well as surveys for other taxa.

Most amphibians and reptiles are secretive animals that require two kinds of efforts to encounter and study them - being in the field when they are active and using standardized trapping and survey techniques to aid in their capture. These very seasonal animals respond to changes in climate, temperature, and precipitation. Enough time in the field in the activity seasons for target species ensures that researchers will encounter these animals. Some species are active and breed in late winter and are not seen or heard for another year (e.g., Spring Peepers). Some are active and breed in the late spring and summer (e.g., American Bullfrogs). One species is active primarily in the fall (Marbled Salamander). Fieldwork must take place when these animals are active in places accessible to us.

My field crew and I conducted a habitat-based inventory of the amphibian and reptile fauna of Jamestown Island and the adjacent portion of the Colonial National Historical Parkway in 2001. This study had the following objectives: (1) obtain a full list of the species of amphibians and reptiles that occur in this area, including any recognized rare and listed species, (2) associate each species with recognized habitat types, (3) provide quantitative estimates of relative abundance of selected species when standardized protocols are used, and (4) provide management recommendations for these two groups of vertebrates.

## **Methods**

### **Study Area**

The study area consisted of Jamestown Island and the adjacent portion of Colonial National Historical Parkway (including the Neck-of-Land area) on the mainland side from the causeway and bridge that connect the island to the mainland to the bridge at Mill Creek (Figure 1). The

area included in this survey was 2263 acres (914 ha) in size. The island and adjacent mainland support a diversity of habitats occupied by amphibians and reptiles. Upland habitats include several forest types, maintained (mowed) grasslands, and open areas associated with historic developments. Forest types include mixed mesic hardwood forest, successional loblolly pine forest with varying numbers of mixed hardwoods, and bottomland red-maple forest. Wetlands include freshwater marshes, small freshwater ponds, ephemeral pools and marshes, and tidal marsh.

### ***Field Methods***

Field survey work began with initial observations on 1 March 2001 and continued through 10 October 2001. Most of the fieldwork was done during day-long field trips during which sites were selected for surveying and a variety of methods were employed. Dates of our field trips, organized by method, are listed in Appendix 1. The following standardized techniques were used routinely in this study: haphazard visual encounter surveys, frog call surveys at night, larval amphibian surveys with dipnets and minnow traps, snake surveys with minnow traps, road driving at night, and deployment of turtle traps. Visual encounter surveys are conducted by walking haphazardly through a selected habitat and observing active amphibians and reptiles, as well as turning over logs and other surface objects to uncover animals underneath. Binoculars were employed for searching water surfaces, logs, and other basking places for turtles. Such data are presented in the database as site occurrence records. Frogs call at night, especially during wet weather, and advertise their presence. We spent several evenings throughout the spring and summer months driving the study area and listening for frog choruses. Frog calls were not taped or evaluated, as the higher priority was to capture frogs for identification and photographs. Thus, the frog call survey technique was used primarily for inventory purposes. Larval amphibian surveys were accomplished in two ways, dip-netting and minnow traps. A D-ring dipnet was used to sample aquatic habitats when water was present, however, all of the shallow freshwater habitats dried up by mid-summer. Minnow traps were also used in aquatic habitats. A variable number was set on one day in a wetland (ephemeral marsh, vernal pool, pond) and pulled up the next day to check for species captured. This technique also allowed for quantification, as number of captures can be expressed in terms of number of individuals per trap day. In all cases when turtle and minnow traps were used, traps were set on one day and pulled out the next. The use of minnow traps in shallow aquatic habitats is also effective for semi-aquatic snakes. Several individuals were captured with this technique. Five to 25 minnow traps were set in trapping sessions. Driving paved roads at night occasionally revealed amphibians and reptiles on the surface. Several amphibians and reptiles were encountered this way. As with minnow traps, turtle traps were employed on one day and pulled the next. However, unlike minnow traps, turtle traps were baited with sardine cans with holes punched in the top. This allows the smell to dissipate from the trap and prevents turtles from eating the bait. One to 3 turtle traps were set during trapping sessions in freshwater ponds on the island. There are no wetlands in the Neck-of-Land area that could be trapped with turtle traps. Data are presented as number of turtles captured per 10 trap days. Finally, my assistant and I conducted two shoreline and marsh surveys by canoe and small Jon boat. This technique revealed few amphibians and reptiles, but did allow detection of several muskrat mounds in the marshes (location data provided to Chuck Raftkind via an interim report). The techniques commonly used for amphibians are described fully in

Heyer et al. (1994) and Mitchell (2000). The techniques for reptiles are described in Jones (1986), Mitchell (1994), and Blomberg and Shine (1996).

Figure 1. Amphibian and reptile survey location on Jamestown Island and the adjacent mainland (Neck-of-Land), for Colonial National Historical Park. The red perimeter line is the boundary of the study area, and the numbered dots are the survey sites.



## ***Animals and Data***

All captured animals were handled in accordance with VA Department of Game and Inland Fisheries guidelines (these are actually national guidelines) and no animal was harmed in the process. Each animal was released at the site of capture.

GPS coordinates of all sites of capture were obtained from aerial photographs in Arc view and plotted on an aerial photo of the study area (Figure 1). All data were entered on standardized field data sheets and subsequently entered into computerized format (Excel spreadsheets).

Photographs (digital and photographic slides) were taken of most species and their habitats. The spreadsheet and photographs are provided as supplements to this report.

## **Results**

### ***Survey Results***

Eleven species of frogs, seven species of salamanders, seven species of turtles, three species of lizards, and eight species of snakes were encountered in the study area during this study at 155 separate study sites (Table 1, Figure 1). These totals include observations based on adults and larvae; the distinction in numbers is provided for amphibians in Table 1. These species were not distributed evenly between mainland (Neck-of-Land) and island locations. Two species of frogs (American Toad, Eastern Spadefoot) were found only on the mainland and three species (American Bullfrog, Northern Green Frog, Spring Peeper) were found only on the island. One species of salamander (Red-backed Salamander) occurred only on the mainland and one (Two-toed Amphiuma) was found only on the island. We found the Atlantic Coast Slimy Salamander only on the island but the Virginia Division of Natural Heritage (VaDNH) found one in the Neck-of-Land area at Site 82. One species of freshwater turtle (Spotted Turtle) was found only on the island; none was found exclusively on the mainland. The Diamond-backed Terrapin occurs in tidal and estuarine marsh habitats exclusively and single observations were made on the island and mainland side of the marsh. One species of lizard (Ground Skink) was limited to the mainland. One snake (Eastern Garter Snake) occurred only on the mainland but two species (Northern Watersnake, Rough Greensnake) were found only on the island. One lizard (Six-lined Racerunner) was not found during this survey, although one observation record from 1991 is in

*Table 1. Checklist of the amphibians and reptiles on Jamestown Island and adjacent mainland in Colonial National Historical Park, Virginia.*

*Total number of sites is 155 and total number of individuals is 801. Relative abundance number codes for island and mainland areas are 0 = no observations, 1 = 1 observation, 2 = 2-5 observations, 3 = 6-10 observations, 4 = > 10 observations. The single slimy salamander (a) in the Neck-of-Land area was observed by VA Division of Natural Heritage (VaDNH) personnel in 2001 and the single six-lined racerunner (b) was observed by VaDNH personnel in 1991; they are not included in total counts. For frogs and salamanders with larval life history, stages the numbers of individuals are adults and juveniles/larvae (tadpoles for frogs). All individual reptiles are adults and immatures.*

Scientific name	Common name	No. Sites	No. Individuals	Island	Mainland
Frogs			Ad/larvae		
<i>Bufo americanus americanus</i>	American Toad	1	1/0	0	1
<i>Bufo fowleri</i>	Fowler's Toad	9	10/0	3	2
<i>Hyla chrysoscelis</i>	Cope's Gray Treefrog	8	31/0	2	4
<i>Hyla cinerea</i>	Green Treefrog	18	37/0	4	4
<i>Hyla squirella</i>	Squirrel Treefrog	3	5/0	1	2
<i>Pseudacris crucifer crucifer</i>	Northern Spring Peeper	3	9/3	4	0
<i>Scaphiopus holbrookii</i>	Eastern Spadefoot	1	2/0	0	2
<i>Rana catesbeiana</i>	American Bullfrog	4	5/1	3	0
<i>Rana clamitans melanota</i>	Northern Green Frog	9	6/114	4	0
<i>Rana sphenoccephala utricularia</i>	Southern Leopard Frog	19	27/37	4	2
<i>Gastrophryne carolinensis</i>	E. Narrow-mouthed Toad	7	7/0	2	2
Salamanders					
<i>Ambystoma maculatum</i>	Spotted Salamander	3	1/13	4	2
<i>Ambystoma opacum</i>	Marbled Salamander	21	44/53	4	3
<i>Hemidactylium scutatum</i>	Four-toed Salamander	4	4/0	2	0
<i>Plethodon chlorobryonis</i>	Atlantic Coast Slimy Salamander	1	8	3	1 (a)
<i>Plethodon cinereus</i>	Red-backed Salamander	7	33	0	4
<i>Amphiuma means</i>	Two-toed Amphiuma	1	4/0	2	0
<i>Notophthalmus viridescens viridescens</i>	Red-spotted Newt	11	27/0	4	2
Turtles					
<i>Chelydra serpentina</i>	Common Snapping	13	24	4	2

serpentina	Turtle				
Chrysemys picta picta	Eastern Painted Turtle	7	34	4	1
Clemmys guttata	Spotted Turtle	5	13	4	0
Malaclemys terrapin terrapin	Northern Diamond-backed Terrapin	2	2	1	1
Pseudemys rubriventris	Red-bellied Cooter	3	3	2	1
Terrapene carolina	E. Box Turtle	31	70	4	4
Kinosternon s. subrubrum	Eastern Mud Turtle	23	45	4	2
Lizards					
Eumeces fasciatus	Five-lined Skink	34	77	4	4
Eumeces laticeps	Broad-headed Skink	3	4	1	2
Scincella lateralis	Ground Skink	1	1	0	1
Cnemidophorus sexlineatus	Six-lined Racerunner	1 (b)	1	1	
Snakes					
Carphophis amoenus amoenus	Worm Snake	10	14	3	3
Coluber constrictor constrictor	Northern Black Racer	6	6	2	2
Diadophis punctatus edwardsii	Northern Ring-necked Snake	3	4	1	2
Elaphe obsoleta obsoleta	Black Ratsnake	7	7	3	1
Nerodia sipedon sipedon	Northern Watersnake	4	10	4	0
Opheodrys aestivus	Rough Greensnake	1	1	1	0
Storeria dekayi dekayi	Northern Brownsnake	2	2	1	1
Thamnophis sirtalis sirtalis	Eastern Gartersnake	2	2	0	2



the VaDNH files for the island shoreline about at the halfway point of the island just south of Site 152 (this record was provided by VaDNH personnel after this study was completed). No species of venomous snakes were encountered during this survey, and no museum or modern observations are available for Jamestown Island. The two VaDNH records are not included in species and individual number totals presented here. A summary of the species of amphibians and reptiles encountered by each survey method is in Table 2. It demonstrates the value of the experienced field herpetologist doing the old-style haphazard searching method; the guy with a snake hook.

A total of 801 individual amphibians and reptiles were captured at 155 sites during the course of this study (Table 1). There were 482 amphibians (295 frogs, 187 salamanders) and 319 reptiles (191 turtles, 82 lizards, 46 snakes) in this sample. Totals include all individual adults and amphibian larvae. Pond-breeding frogs (genus *Rana*) dominated the frog fauna on the island, but the treefrog (genus *Hyla*) fauna dominated on the mainland. The salamander fauna on the island consisted mostly of pond and pool-breeding species, such as the ambystomatids (Marbled, Spotted) and newts. The freshwater turtle fauna was most abundant on the island due to the presence of pond habitats. The Eastern Box Turtle was abundant on both the mainland and the island and should be viewed as an important sentinel species. The dominant lizard species on both the mainland and the island was the Five-lined Skink. The snake fauna was the most difficult to sample due to their secretive habits. Thus, their relative abundance was highly variable between mainland and island locations. The occurrence of Northern Watersnakes only on the island may reflect the lack of pond habitats on the mainland side.

No federal or state endangered or threatened species was found during this survey. Sources of mortality from human activities documented in this survey include road-killed frogs and turtles and Red-bellied Turtles killed by boat propellers in Powhatan Creek. An indirect source of mortality is loss of microhabitat by removal of logs and snags along the loop road on the island (see Habitat associations).

### **Habitat associations**

Six habitat types derived from the list provided by the VaDNH proved meaningful for reptiles and amphibians (Table 3). Many of the amphibians and reptiles that use terrestrial habitats were encountered in uplands supporting mixed mesic hardwoods and successional loblolly pine (with some hardwood mix). Bottomland forest habitat was not extensive in the study area and only two widespread species, one frog (Southern Leopard Frog) and one snake

Table 2. Species obtained by the various inventory methods used in this survey. Refer to the text for explanations of the methods indicated.

Common name	VES haphazard	Dipnets	Minnow traps	Turtle traps	Road cruising	Frog calls
Frogs						
American Toad	X				X	X
Fowler's Toad	X				X	X
Cope's Gray Treefrog	X	X				X
Green Treefrog	X				X	X
Squirrel Treefrog	X					
Northern Spring Peeper	X	X				X
Eastern Spadefoot					X	X
American Bullfrog	X		X	X		X
Northern Green Frog	X	X	X		X	X
Southern Leopard Frog	X	X	X		X	X
E. Narrow- mouthed Toad					X	X
Salamanders						
Spotted Salamander	X	X				
Marbled Salamander	X	X				
Four-toed Salamander	X					
Atlantic Coast Slimy Salamander	X					
Red-backed Salamander	X					
Two-toed Amphiuma			X			
Red-spotted Newt		X	X			
Table 2 continued						

Common name	VES haphazard	Dipnets	Minnow traps	Turtle traps	Road cruising	Frog calls
Turtles						
Common Snapping Turtle	X			X	X	
Eastern Painted Turtle	X			X		
Spotted Turtle	X			X		
Northern Diamond-backed Terrapin	X					
Red-bellied Cooter	X					
Eastern Mud Turtle	X			X	X	
E. Box Turtle	X				X	
Lizards						
Five-lined Skink	X					
Broad-headed Skink	X					
Ground Skink	X					
Snakes						
Worm Snake	X					
Northern Black Racer	X				X	
Northern Ring- necked Snake	X					
Black Ratsnake	X				X	
Northern Watersnake	X		X		X	
Rough Greensnake	X					
Northern Brownsnake	X					
Eastern Gartersnake	X					

*Table 3. Relative abundance of amphibians and reptiles of Jamestown Island and adjacent mainland in Colonial National Historical Park, Virginia, by habitat type. Habitat types are based on classifications provided by the VA Division of Natural Heritage (Fleming et al., 2001). Relative abundance codes are 1 = one observation, 2 = 2-5 observations, 3 = 6-10 observations, and 4 = 11+ observations. The single six-lined racerunner (a) was on the beach adjacent to successional loblolly pine habitat.*

Common name	Mixed Mesic Hardwoods	Succes. Loblolly Pine	Bottomland Forest	Ponds	Vernal Pools	Tidal Marsh
Frogs						
American Toad		1				
Fowler's Toad		2			2	2
Cope's Gray Treefrog		4			4	
Green Treefrog					4	4
Squirrel Treefrog					2	
Northern Spring Peeper	3	2			3	1
Eastern Spadefoot					2	
American Bullfrog	1			3		
Northern Green Frog		4		4	4	
Southern Leopard Frog		4	4	4	4	4
E. Narrow-mouthed Toad		2			2	1
Salamanders						
Spotted Salamander	4	1			4	
Marbled Salamander	4	4			4	
Four-toed Salamander		2				
Atlantic Coast Slimy Salamand.	3	2				
Red-backed Salamander	4	4				
Two-toed Amphiuma				2		
Red-spotted Newt				2	4	
Table 3						

Common name	Mixed Mesic Hardwoods	Succes. Loblolly Pine	Bottomland Forest	Ponds	Vernal Pools	Tidal Marsh
continued						
Turtles						
Common Snapping Turtle				4	2	1
Eastern Painted Turtle		2		4	1	
Spotted Turtle				3	4	
Northern Diamond-backed Terrapin						2
Red-bellied Cooter		2				1
Eastern Mud Turtle	2	4		4	4	2
E. Box Turtle	4	4				
Lizards						
Five-lined Skink	4	4				
Broad-headed Skink	1	2				
Ground Skink		1				
Six-lined Racerunner		1 (a)				
Snakes						
Worm Snake	4	2				
Northern Black Racer	2	2				
Northern Ring-necked Snake	2	2				
Black Ratsnake			3			
Northern Watersnake				4	2	1
Rough Greensnake		1				
Northern Brownsnake		2				
Eastern Gartersnake	2					

a - grassland habitat only

(Black Ratsnake), were encountered. Most of the uplands supported adults and juveniles of frogs and salamanders that use aquatic sites for reproduction. This is because these life history stages disperse widely and use uplands during non-breeding periods. Permanent ponds supported two species (American Bullfrog and Two-toed Amphiuma) not found in vernal pools. Vernal pools supported many species not found in permanent ponds or tidal marsh habitat. These include Cope's Gray Treefrog, Squirrel Treefrog, Eastern Spadefoot, Spotted Salamander, and Marbled Salamander. Ponds supported 10 species and vernal pools supported 17 species. Tidal marshes present severe limits on amphibians and some reptiles due to the salt content of the water. However, 5 species of frogs, 4 species of turtles, and one snake species use this habitat type. The Northern Diamond-backed Terrapin is exclusively estuarine, although it ventures on land to lay eggs.

Several species of amphibians and reptiles use logs and snags as essential microhabitat. A survey of logs and snags marked for removal on Jamestown Island showed that six species were directly associated with them, by either hiding under or in these features. These include juvenile Red-spotted Newts, Marbled Salamanders, Five-lined Skinks, Northern Ring-necked Snake, Black Ratsnake, and Eastern Mud Turtle.

### ***Relative abundance***

Some of the inventory work involved surveying freshwater wetlands (ponds, vernal pools) for amphibians and turtles with traps. Comparisons between species and their life history stages reveal the make-up of the amphibian community in the wetland at the time of study and are thus valid from a community standpoint. Estimates of relative abundance (Tables 4 and 5) allow comparisons among species and among sites on Jamestown Island. Results from minnow trapping four wetlands showed that number of species and their relative abundances varied considerably among ponds and vernal pools. Site 2 on the island is a shallow, woodland vernal pool that dried by July. Southern Leopard Frog tadpoles were more abundant than Marbled Salamander larvae or Red-spotted Newt adults. Site 8 is a freshwater pond that retained water during the entire year. Relatively few tadpoles of two species of frogs were found there. Site 18 is a freshwater pond that contained a diverse fauna with three species of frogs (American Bullfrog, Green Frog, Southern Leopard Frog), one salamander (Red-spotted Newt), and one snake (Northern Watersnake). Only Green Frog tadpoles were abundant in this pond. Site 74 is a

Table 4. Relative abundance of amphibians and reptiles in minnow traps on Jamestown Island, Colonial National Historical Park, Virginia. Number of trap days was 20 for Site 2, 47 for Site 8, 55 for Site 18, and 20 for Site 74 with 5-25 traps set each trap day. A trap day is a 24-hour period extending from the morning of the first day. Trap effort was standardized to 50 traps per site for comparison, thus, values are number per 50 trap days. Refer to Figure 1 for locations of the sites.

Species	Common name	Life history stage	Site 2	Site 8	Site 18	Site 74
Frogs						
R. catesbeiana	Amer. Bullfrog	Tadpoles	---	---	0.050	0.125
R. clamitans	Green Frog	Tadpoles	---	0.677	1.239	---
R. sphenoccephala	S. Leopard Frog	Tadpoles	2.000	0.226	0.083	0.375
Salamanders						
A. opacum	Marbled Salam.	Larvae	0.625	---	---	---
N. viridescens	Red-Spot. Newt	Adults	0.438	---	0.050	0.125
A. means	Amphiuma	Adults	---	---	---	0.050
Snakes						
N. sipedon	N. Watersnake	Adults	---	---	0.116	---

Table 5. Relative abundance of adult freshwater turtles in three freshwater ponds on Jamestown Island, Colonial National Historical Park, Virginia. Number of trap days was 4 for Site 8, 9 for Site 18, and 3 for Site 74 using 1-3 turtle traps during each 24 h trap day. Trapping effort was standardized for comparisons among sites based on number of turtle captures per 10 trap days. Thus, each number is the number of turtles captured per 10 trap days. Refer to Figure 1 for locations of the sites.

Species	Common Name	Site 8	Site 18	Site 74
Chelydra serpentina serpentina	Common Snapping Turtle	1.875	0.247	4.444
Chrysemys picta picta	Eastern Painted Turtle	2.500	2.222	8.889
Clemmys guttata	Spotted Turtle	--	0.247	--
Kinosternon subrubrum subrubrum	Eastern Mud Turtle	0.625	1.235	1.111

permanent freshwater pond located adjacent to the bus parking lot on the island. It supported two species each of pond-breeding frogs (American Bullfrog, Southern Leopard Frog) and salamanders (Red-spotted Newt, Two-toed Amphiuma); it is the only location that yielded the completely aquatic Amphiuma.

Several species of freshwater turtles are common throughout the island and occasionally use the terrestrial habitats on the mainland. All sites trapped with standard turtle hoop traps were permanent ponds that did not dry during the course of this survey. Each of the sites contained three species of relatively abundant turtles (Table 5). Common Snapping Turtles and Eastern Painted Turtles were more abundant in Site 74 than in either of the other two ponds studied. The Eastern Mud Turtle was nowhere abundant but it is highly terrestrial and does not concentrate in ponds. The Spotted Turtle was found only in Pond 18, although several were caught by hand in two of the vernal pool complexes on the island. It should not be considered an abundant turtle.

## Discussion

Identification of the extant species of amphibians and reptiles and the habitats they occupy derived from a modern survey can provide insights into the natural and cultural history that occurred here nearly 400 years ago. The habitats present on Jamestown Island today are probably not dramatically different from four centuries ago. Although most of the upland portion of the island was cultivated until 1925, some habitat remained (Cotter, 1958). Pine stands were in abundance, as were some hardwoods, and freshwater wetlands were present then as now. The tidal marsh in and around the island is likely to be similar to the one present in the 1600s. Thus, most of the species of amphibians and reptiles that occupy such habitats today are likely the same species that were present in 1607. The exceptions are Timber Rattlesnakes (*Crotalus horridus*) and Copperheads (*Agkistrodon contortrix*). The former species was extirpated from large areas east of the Blue Ridge Mountains following colonization and farming (Mitchell, 1994). The latter snake is still widespread in Virginia and occupies a variety of habitats (Mitchell, 1994; Mitchell and Reay, 1999). The lack of modern records for Jamestown Island suggests that the colonists and perhaps others that followed killed all the Copperheads and possibly the Timber Rattlesnake on the island. It is possible that Copperheads do occur on the island but in low numbers and simply not encountered. These snakes, as well as others, probably instilled a great fear in the Colonists, as England has only three species of small snakes (Arnold and Burton, 1978). Encounters with large snakes, especially large-bodied Black Ratsnakes and Copperheads, certainly instilled fear in these people and likely affected their behavior when they ventured away from the fort. The Colonists would have also heard the same species of frogs calling as those found in this modern survey. They probably did not venture out at night much and were unaware of what was making those night sounds. Unfortunately, little was written on the amphibians and reptiles on Jamestown Island during the Colonial Era; indeed, little has been written about these animals in the early American literature. The writings of Captain John Smith (Smith, 1612) mention a few snakes and turtles but mostly as food items and ornaments used by the Native Americans. Other writings from that era add little to no information on this topic. Thus, it is difficult to make more than a few suggestive inferences about the effect the native amphibian and reptile fauna had on the early Colonists. A species-by-species evaluation of their behavior and habitat use versus human activities known for that early period could be instructive and could lead to insights into how the Colonists reacted to the native fauna.



The species encountered during this survey represent a robust list for the study area, at least for all groups except snakes. This was the result of fieldwork that was conducted over three seasons (all but Winter) using a variety of search and capture techniques, searches conducted during day and night activity periods, and geographic coverage throughout the Jamestown Island and adjacent mainland area. Except for snakes, I am confident that the species lists are 90% or more complete. Snakes are especially hard to survey because they are so secretive. They are active for only short periods of time and often only during favorable weather, usually warm and wet periods.

Based on distribution patterns of amphibian and reptile species in Virginia (Mitchell, 1994; Mitchell and Reay, 1999), most of the species encountered during this survey were expected. The species we did not encounter but were expected to be in the study area include the Southeastern Chorus Frog (*Pseudacris feriarum*), Stinkpot (*Sternotherus odoratus*), Southeastern Five-lined Skink (*Eumeces inexpectatus*), Northern Fence Lizard (*Sceloporus undulatus*), Copperhead (*Agkistrodon contortrix*), Rainbow Snake (*Farancia erythrogramma*), Eastern Hognosed Snake (*Heterodon platirhinos*), Eastern Kingsnake (*Lampropeltis getula*), Northern Red-bellied Snake (*Storeria occipitomaculata*), Eastern Ribbonsnake (*Thamnophis sauritus*), Rough Earthsnake (*Virginia striatula*) and Smooth Earthsnake (*Virginia valeriae*). Neither Chorus Frogs nor Stinkpots tolerate salt water and were not expected on Jamestown Island. Their lack of occurrence in the Neck-of-Land area is a reflection of the lack of appropriate microhabitat. The lizards and snakes listed above should occur either on the island or Neck-of-Land or both. We did not encounter them for several possible reasons, including the historical use of the land resulting in a disturbed environment that eliminated these species sometime in history and luck-of-the-draw during our survey. There is abundant habitat for Copperheads on both Jamestown Island and on the Neck-of-Land area. Their absence was surprising. The Two-toed Amphiuma (*Amphiuma means*) was the only species not expected in this survey. Its occurrence on Jamestown Island was a surprise, as it must have in some time in history crossed through brackish water to gain access to the island pond in which it was found.

The most abundant amphibian on the island was the Southern Leopard Frog. This species occurs in a wide variety of habitats and is widespread in the mid-Atlantic region. It is able to breed in both fresh and slightly brackish water. The most abundant species of reptile were the Five-lined Skink and the Eastern Box Turtle. We found many of these lizards and turtles in the hardwood and hardwood/pine habitats. The downed woody debris (logs) and standing snags are preferred habitat for the skink; and this habitat type occurs in abundance on the island. The Eastern Box Turtle thrives in hardwood forests with abundant ground herbaceous cover. Such habitat is abundant on both Jamestown Island and in the Neck-of-Land area. Indeed, the species most likely to be negatively impacted by construction activities during the Jamestown Island 400 project is the long-lived Eastern Box Turtle. Both of these reptiles should receive some management attention, as their habitat requirements reflect the quality of the landscape on Jamestown Island and on the Neck-of-Land area for the amphibians and reptiles of the region. As noted below, species that require two or more habitat types for reproduction and survival depend on intact and functional habitats of different types.

### **Habitat Associations**

Amphibians and reptiles of Jamestown Island and the adjacent Neck-of-Land occupy a wide variety of habitats. All of the frogs and most of the salamanders known to occur here

depend on freshwater wetlands for reproductive success and population survival. They also use the upland terrestrial habitats extensively outside the breeding season. The terrestrial reptiles that include most of the snakes, all of the lizards, and one turtle (Eastern Box Turtle) depend on intact forested habitats for survival. The existing forests on Jamestown Island and in the Neck-of-Land area provide excellent habitat for most of these species. Finally, the tidal marsh is used extensively by several turtles, one exclusively (Diamond-backed Terrapin), and at least one snake (Northern Watersnake) and one frog (Southern Leopard Frog). Amphibians and reptiles, as do other animals, function in landscape context. The mix of habitat types on Jamestown and vicinity are essential to the existence of these vertebrates in the park. They should be viewed as a habitat matrix at the landscape level rather than as separate habitat types. Long-term management of habitats in Colonial National Historical Park would be well served if management issues and potential construction impacts were viewed from this perspective.

An example of the landscape concept from the amphibian perspective is the matrix of freshwater vernal pools used for breeding by two species of salamanders and the surrounding forest. Spotted Salamanders and Marbled Salamanders (in the genus *Ambystoma*) were found predominately in the intact hardwood forest east of the gate to the loop roads on Jamestown Island. This habitat also contains several vernal pools. These predominately subterranean salamanders breed in the vernal pools over a short period of time but otherwise spend most of their lives in the surrounding forest. The hardwood forest creates the underground tunnel matrix needed by these salamanders; they seldom create their own burrows. The combination of these two habitat types meets the life history requirements of these two salamanders. Lack of one of the habitat types results in the absence of these two species. Corridors of appropriate hardwood habitat connecting two patches of hardwood forests or two areas with vernal pools are essential features of the landscape that greatly influence the viability of ambystomatid salamander populations. Thus, viewing habitats in a landscape context is essential to population survival and effective species management.

Microhabitats used in the forested habitats in the park include downed and decaying logs and snags. I found six species directly associated with such features. Unfortunately, many within sight of the loop roads on the island were marked for removal. Taking away such microhabitat features will directly kill individual animals, remove the valuable shelter sites, and possibly contribute to the population decline of these species. Such removal for non-biological reasons may conflict with National Park Service directives to maintain all native species in each park as viable populations. This is a management issue that deserves evaluation.

### ***Potential impacts of development alternatives***

The potential impact of construction activities during the Jamestown Island 400 project on amphibians and reptiles is variable. All of the alternatives, except the no action one, proposed for the preparation of the area for the Jamestown Island 400 project will impact these vertebrates in some way. Aside from the fact that there are no federal or state-listed species in the area, there will be loss of habitat used by amphibians and reptiles. Most of the habitats targeted for impact containing these species are in the Neck-of-Land area. The modifications proposed for the public areas on Jamestown Island are in areas already severely impacted. Most of the amphibian and reptile use of the latter is by individuals that traverse these spaces during movements from place to place. Loss or decline of populations will occur in the Neck-of-Land area if the parking lots

are constructed. Although this area is reclaimed farmland in a state of ecological succession, it does harbor several species, some of which may be abundant. This is especially true of the long-lived Eastern Box Turtle. The Box Turtle population in Neck-of-Land is large, as evidenced by the large number of animals captured. These animals have life histories very much like humans, with maturity in the teens, survival well past age 50 (some documented to live over 100 years), and repeated reproduction. The differences between humans and the turtles include poor juvenile survival in the latter and the fact that these turtles do not become senile or non-reproductive with age. Thus, the older individuals in the population are the most valuable members. Loss of habitat will directly impact these turtles and likely cause the death of some to many of these older individuals.

Except for Alternatives A and D, the primary conclusions about the impact of construction activities on amphibians and reptiles are essentially the same among the remaining proposed alternatives. The variation depends on the location of parking lots, trail placement, and the boat docks.

Alternative A (No action) - Maintaining the landscape at the current level of development and allowing ecological succession to take its course will do the least harm to the amphibian and reptile fauna on Jamestown Island and the Neck-of-Land area. These species will continue to maintain viable populations for the foreseeable future.

Alternative B - All of the proposed construction sites in the Neck-of-Land area (numbers 1-8) will cause loss of habitat used by amphibians and reptiles. The Gateway/Orientation facility and associated parking lots and the boat docks will require elimination of natural habitat. The trails will open the forest to the kind of pedestrian and bike traffic that will result in the direct loss of individuals. Box turtles will be picked up and kept or at least moved out of their home ranges, and bikes will run over small amphibians and reptiles on the trail or road bed. The Box Turtle population will decline. Construction of the proposed additional 3 boat docks will cause an increase in boat traffic in Powhatan Creek and Back River. Evidence already gained in this study of mortality caused by boat traffic on turtles (see Results and the PowerPoint file) shows that boat propellers kill these long-lived animals. Additional traffic will result in further population decline.

Most of the proposed construction on Jamestown Island appears to be in areas already developed and should add little additional impact to that already in place with existing features. The hiking and biking trails proposed along the existing roadway will have little to no impact on amphibians and reptiles. The wetland between the NPS building and Dr. William Kelso's house should be avoided, as it supports a variety of amphibian and reptile species. There should be no encroachment into the Pitch and Tar Swamp as these animals use it extensively.

Alternative C - All of the proposed construction sites in the Neck-of-Land area (numbers 1-7) will cause loss of habitat used by amphibians and reptiles. The Gateway/Orientation facility and associated parking lots and the boat docks will require elimination of natural habitat. The trail between the proposed parking lot (2) and the new northern edge of the forest will have less impact than that proposed under Alternative B. However, Eastern Box Turtles will still be encountered and be picked up and kept or at least moved out of their home ranges. The Box Turtle population will decline. Construction of the proposed additional 3 boat docks will cause an

increase in boat traffic in Powhatan Creek and Back River. Evidence already gained in this study of mortality caused by boat traffic on turtles (see Results) shows that boat propellers kill the long-lived animals. Additional traffic will result in further population decline.

Most of the proposed construction on Jamestown Island appears to be in already developed areas and should add little additional impact to that already in place with existing features. The hiking and biking trails proposed along the existing roadway will have little to no impact on amphibians and reptiles. The wetland between the NPS building and Dr. William Kelso's house should be avoided, as it supports a variety of amphibian and reptile species. There should be no encroachment into the Pitch and Tar Swamp.

Alternative D - Of all the alternatives with some construction proposed, this one has the least impact on amphibians and reptiles. This alternative will result in no loss of habitat in the Neck-of-Land area. The result will be that the large Eastern Box Turtle population, along with other species in this area, will continue to remain viable. The lack of new boat docks will allow the aquatic species of turtles to exist at current population levels; mortality should remain at present-day levels.

Most of the proposed construction on Jamestown Island appears to be in already developed areas and should add little additional impact to that already in place with existing features. The hiking and biking trails proposed along the existing roadway will have little to no impact on amphibians and reptiles. The wetland between the NPS building and Dr. William Kelso's house should be avoided, as it supports a variety of amphibian and reptile species. There should be no encroachment into the Pitch and Tar Swamp.

Alternative E - All of the proposed construction sites in the Neck-of-Land area (numbers 1-9) will cause loss of habitat used by amphibians and reptiles. The Gateway/Orientation facility and associated parking lots and the boat docks will require elimination of natural habitat. The trails will open the forest to the kind of pedestrian and bike traffic that will result in the direct loss of individuals. Box turtles will be picked up and kept or at least moved out of their home ranges, and bikes will run over small amphibians and reptiles on the trail or road bed. Construction of the proposed additional 3 boat docks will cause an increase in boat traffic in Powhatan Creek and Back River. Evidence already gained in this study on mortality caused by boat traffic on turtles (see Results) shows that boat propellers kill the long-lived animals. Additional traffic will result in further population decline.

Most of the proposed construction on Jamestown Island appears to be in already developed areas and should add little additional impact to that already in place with existing features. The hiking and biking trails proposed along the existing roadway will have little to no impact on amphibians and reptiles. The wetland between the NPS building and Dr. William Kelso's house should be avoided, as it supports a variety of amphibian and reptile species. There should be no encroachment into the Pitch and Tar Swamp.

## **Conclusions**

1. No federal or state endangered or threatened species of amphibian and reptile was encountered during this survey.

2. Most of the species of amphibians and reptiles in the study area are those that occur throughout the Lower York-James Peninsula in Virginia and are generalists in their habits. The exceptions are the Two-toed Amphiuma, a fully aquatic salamander found in freshwater swamps and ponds, and the Northern Diamond-backed Terrapin, an estuarine specialist.
3. Hardwood forests and all aquatic habitats are critical areas to maintain for amphibians and reptiles. Downed woody debris from hardwood forests provides important microhabitat for numerous species. Aquatic habitats are important because they are the only places on the island and adjacent mainland where amphibians can reproduce. These habitats include vernal pools, freshwater marshes, and permanent bodies of water.
4. Removal of downed woody debris from areas along the inner and outer loop roads on Jamestown Island causes the immediate loss of critical microhabitat for many animal species. Their removal could result in reduced population sizes of several species of reptiles on the island. The National Park Service is charged with maintaining viable populations of all vertebrates and the removal of logs and snags may be in conflict with this mandate.
5. Construction of parking areas and additional roadways on Neck-of-Land and on Jamestown Island will negatively impact important populations of amphibians and reptiles no matter which Alternative with planned construction is selected. The Alternative that will have the least impact on amphibians and reptiles is Alternative D.
6. Construction of the boat docks will result in loss of habitat for amphibians and reptiles and increased boat traffic on the areas waterways. Boat propeller strikes are well known cause of mortality of turtles. The discovery of a dead adult female Red-Bellied Cooter in Powhatan Creek with three large propeller gashes in the shell (see the PowerPoint file) attests to this recreational activity being a cause of mortality for these turtles. Current levels of boat traffic and their effects on the native vertebrates should be evaluated. The increased traffic derived from additional opportunities provided by the new boat docks will only exacerbate a current management problem.
7. The effects of the proposed trails in the various Alternatives for the Jamestown Island 400 project on amphibians and reptiles are varied. They range from little impact for trails along existing roads in the existing public areas to considerable impact in areas currently lacking trails in the Neck-of-Land area. Any change to the hardwood forest in the Neck-of-Land area will have consequences to the Box Turtle population. Garber and Burger (1995) found that opening an area to recreation resulted in the complete loss of a Wood Turtle population. The primary cause was removal of turtles by humans and dogs. Humans pick up Box Turtles and will remove them or at least carry them to other locations in the park (perhaps the island). The effect is the same as the individuals being killed by a predator or on the road by a vehicle - loss of the important individual to the population. Bike traffic may kill small amphibians and reptiles but this is of less concern than the direct human impact to turtles. Thus, trail construction of any kind in hardwood forests will negatively affect the sentinel Box Turtle species.

8. The mixed hardwood forest in the Neck-of-Land area (and on the island) harbors a large population of Eastern Box Turtles, many of which are 30-100 years old. Removal of portions of this hardwood area and the construction process itself will likely kill an unknown number of these turtles. Box Turtles are sentinel species for a variety of reasons as noted above. Because they are so long-lived, they accumulate chemicals from the environment. A good example is the production of aural (ear) abscesses in these turtles as a result of vitamin A deficiency caused by organochlorine pesticide contamination (Holliday et al., 2001). Nearly all turtles found in the Blacksburg, Virginia area had levels of these chemical in their systems. A healthy Box Turtle population reflects a healthy environment. We did not find aural abscesses in turtles during this study, suggesting that this may not be a problem in this area. Increased contamination of environmental pollutants from increased human use of the area during the Jamestown Island 400 event may be an indirect cause of problems for this species, in addition to the habitat loss and population decline from the construction process. Thus, it is appropriate to view the Eastern Box Turtle population from conservation and management perspectives.

9. The island is small enough for individuals of most species to move from one end to the next in one season, as amphibians and reptiles are well known to disperse hundreds of meters and up to several kilometers. Thus, with the exception of the two species noted in Number 2, specific habitats do not harbor specific species. Most of the habitats on the island and adjacent mainland are likely to harbor all of the species known from the study area at some time during their history.

10. The variety of habitat types on Jamestown and vicinity should be viewed as a habitat matrix at the landscape level rather than as separate habitat types. Long-term management of habitats in Colonial National Historical Park would be well served if management issues and potential construction impacts were viewed from this perspective.

11. The natural history of Jamestown Island and vicinity was a very important backdrop to the cultural history that occurred here. Historians and interpretive staff should not ignore the flora and fauna. It would be most beneficial to visitors to gain an appreciation of the natural history of the island and how it influenced the cultural history.

## Management Recommendations

1. Maintain all habitats used by amphibians and reptiles, especially hardwood forests and ephemeral freshwater wetlands. Make sure that there is at least a large (>165 meter) buffer around each of the freshwater wetlands to the extent possible (see Semlitsch and Jensen, 2001 for reasons supporting the distance). Such habitats are not abundant on Jamestown Island and support several species that would not occur there if these habitats were missing or altered. The pure hardwood stand to the east of the gate to the loop road with its vernal pools is a prime example of an area in need of management attention. In short, keep Jamestown Island in as a natural state as possible.
2. Other habitats used extensively by amphibians and reptiles include the freshwater wetland on the eastern end of the island, Pitch and Tar Swamp, the ephemeral marsh area to the east of the eastern end of the public area (field), the shallow moats around the Civil War forts on the island and in the Neck-of-Land area, and the mixed pine and hardwoods with the snags and downed logs. A very important wetland for frogs is the ephemeral cypress tree marsh immediately south of the Glass House public area. Several species of frogs occur here and nowhere else in this area. These habitats should be surveyed, mapped, and evaluated for their value to the wildlife (in the broad sense) in the park. Resource management of all of these habitats would benefit from additional and more intensive survey and population research in these habitats.
3. Allow downed woody debris (logs and snags) to accumulate in all forest habitats. This will help maintain many amphibian and reptile populations. Removal of downed woody debris (logs, snags) along the viewing areas of the loop roads on the island and other locations will cause animal population decline. Such policies should be reviewed in light of NPS mandates to protect native species.
4. If the Alternative selected for implementation for the Jamestown Island 400 project is one that causes loss of portions of the hardwood forest in the Neck-of-Land area and construction of parking lots, boat docks, and trails, then consultation with qualified ecologists and conservation biologists should be undertaken to help find ways to minimize the negative impacts. Loss of habitat and, subsequently, individual animals from human actions will cause the long-lived, sentinel Box Turtle population to decline. Decline and loss of individuals cannot be prevented but could be reduced somewhat through a variety of actions that minimize the amount of habitat lost and the number taken. Work with people who know these animals, their habitats, and human behavior.
5. The effects of boat traffic and propeller damage to turtles in Powhatan Creek and Back River should be evaluated. What is the rate of mortality to these animals? Are Diamond-backed Terrapins (a species in decline) affected?
6. The Eastern Box Turtle population in the Neck-of-Land area should be studied quantitatively. What is the population size of this long-lived vertebrate and its demographic makeup? Are there any turtles with organochlorine pesticides in their tissues? What is the rate of aural infections? Are they diseased in any other way? This sentinel species is abundant now on the island and in

the Neck-of-Land area. A comparison of these two populations with an emphasis on incidence of disease would allow a much better understanding of these two environments and whether any management problems occur and should be corrected.



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**Appendix 1. Dates of field trips for the amphibian and reptile survey, Jamestown 400 Project area by inventory method.**

Haphazard VES	Mar 1, 13, 28; Apr 6, 14, 26, 27; May 1, 16, 21, 26; Jun 1, 6, 7, 15, 25, 29; Jul 5, 11, 19, 27; Aug 26; Sep 5, 6, 21, 25, 26; Oct 2, 4, 10
Dipnets	Mar 13; Apr 14, 27; May 1, 2; Jun 1, 15; Sep 5, 6
Minnow traps	Mar 28-29, May 1-2, May 31-Jun 1, 14-15; Sep 5-6
Turtle traps	Apr 26-27; May 1-2; Jun 14-15; Sep 5-6
Road cruising	Mar 13, 28; May 16, 21; Jun 1, 6, 15; Sep 21
Frog calls	Mar 13; May 2, 16, 21; Jun 1, 6, 7, 15